REMR TECHNICAL NOTE EM-CR-1.4

PIPE CORROSION MONITOR

PURPOSE: To describe an electrical polarization technique for assessing the corrosion status of inaccessible underground coated pipes.

APPLICATION: Determining or monitoring the corrosion status of underground pipes by measuring the decay rate of an electrically charged pipe.

ADVANTAGES: A single setting of the pipe corrosion monitor can provide the corrosion status of up to 10,000 linear ft of electrically continuous piping, thereby significantly reducing the number of excavations, and making the procedure less personnel-intensive and less expensive than the digging of test areas and inspection method.

LIMITATIONS: Soil properties play a role in use of the pipe corrosion monitor.

AVAILABILITY: A detailed description of the system and complete specifications are available and can be furnished upon request to the point of contact.

COST: The components and assembly of the monitor cost about $3,000. In contrast, the excavation procedure costs about $1,000 per hole, which makes this method quite costly. Large numbers of excavations (30 to 40) are usually required to determine corrosion status at an Army installation.

FIELD PERFORMANCE: The pipe corrosion monitor has been successfully field-tested at Fort Riley, Kansas, and at Fort Polk, Louisiana.

BACKGROUND: Assessing the corrosion status of inaccessible underground coated pipes has long been a problem, but is required to obtain the life-cycle cost analysis necessary for making projected repair or replacement decisions. The development of a life-cycle cost analysis of these pipelines has often been thwarted by a lack of knowledge of how badly they are corroded. Buried pipe is usually inspected by digging test areas ("bell holes") over the pipe, removing its coating, and visually inspecting the bare steel surface. Since this process is expensive, the number of underground pipelines that can be economically inspected is limited. To solve this problem, the Construction Engineering Research Laboratory (CERL) has developed a monitor to assess the corrosion status of coated underground pipes using electrical polarization techniques that do not require excavation.

DESCRIPTION OF SYSTEM: To measure the decay rate of buried pipes, the pipe corrosion monitor passes a direct current through a temporary ground rod which changes the pipe's electrical potential. The current then flows from the rod to the pipe through the soil. An electrical connection to the pipe is made either at the pipe riser, where the pipe comes out of the ground and goes into the service structure, or by using a probe bar.

A current interrupter shuts the current off 60 times per second from a d-c power source. A voltmeter tuned with the current is momentarily turned off by the interrupter. Therefore, only the "instant off" current potential is measured, and interference from the relatively high resistance is avoided. The IR (current/resistance) drop occurs because the reference cell, such as copper-copper sulphate, is placed on the ground above the pipe. The current flowing from the temporary ground rod to the soil and into the corroded areas of the underground pipe interferes with the noncontacting reference cell on the ground. The rest potential of the pipe is shifted by -150 millivolts.

The current is passed for 1/2 hour while maintaining the off-potential shift at -850 millivolts with respect to the copper-copper sulphate reference cell. Then the current is shut off and the polarized pipe is allowed to decay by the value WV (usually 100 millivolts in time, WT seconds); the relaxation rate R, defined as WV/WT per unit area, is then determined. A chart recorder measures the relaxation rate of the pipe's induced potential.

Figure 1 shows a typical polarization decay plot in tap water for a pipe having 0.1 percent bare area. In the A-B region of the plot, the "instant off" potential is controlled at -150 millivolts shift from the natural rest potential. At B, the controller is shut off and the potential of the pipe is allowed to decay naturally. The corrosion status is then determined from the decay rate.

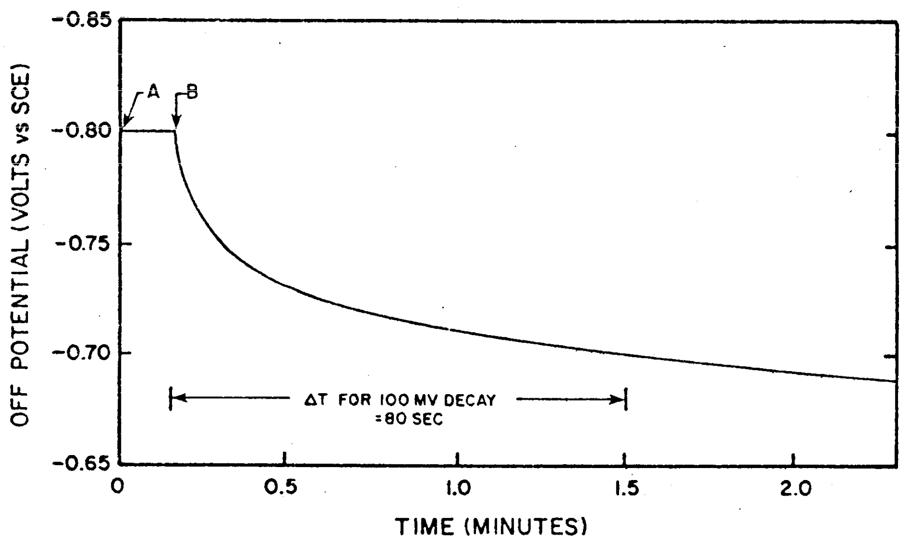

Figure 1. A typical polarization decay plot for a pipe with 0.1 percent bare area.

In conjunction with the pipe corrosion monitor, CERL has developed a computerized Pipe Corrosion Management System (PIPER) which can determine the most cost-effective strategy for pipe maintenance. Information from the monitor can be fed into PIPER so that an economic analysis of repair or replace decisions can be made. PIPER can provide the decision-making tool for assigning priorities to corrosion-related maintenance and repair of underground pipes. It provides fast data storage and retrieval, pipe network definition, a pipe corrosion status index, prediction of future corrosion status based on soil properties, prediction of leaks, and an economic analysis of maintenance options. All of this output can be formatted into user-defined reports.

REFERENCES:

a. Pipe corrosion monitor. A. Kumar, E. G. Segan, J. Bukowski. In: Proceedings, Corrosion 83 Conference, National Association of Corrosion Engineers. Paper No. 254.

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c. The pipe corrosion monitor. A. Kumar. In: The Military Engineer, Vol 77, No. 502, pp 432-433, 1985.